HAND-HELD ELECTRONIC DEVICE WITH MULTIPLE INPUT MODE THUMBWHEEL

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BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to handheld electronic devices ("mobile devices") having an auxiliary input device. Specifically this invention relates to auxiliary input devices such as multiple input mode thumbwheels.

Description of the Prior Art

In most mobile devices with a thumbwheel input, the thumbwheel is oriented so that the thumbwheel would be accessed on a horizontal axis or a vertical axis to the mobile device's housing. A horizontal orientation of a thumbwheel, in relation to the device housing, takes up significant space on the printed circuit board of the device (herein referred to as PCB). A vertical orientation of a thumbwheel, in relation to the device housing adds significant overall thickness to the device and device housing or undesirable protrusion from the housing.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a thumbwheel input device characterized by a wheel having a first axis of rotation whereby a first input is generated by rotation of the wheel about the first axis, and a holder having a second axis of rotation and a portion thereon to receive the wheel whereby a second input is generated by rotation of the holder about the second axis.

In one aspect of the invention, a mobile device includes a thumbwheel as an embodiment of an auxiliary input device. In most mobile devices with a thumbwheel input, the thumbwheel is oriented so that the thumbwheel would be accessed on a horizontal axis or a vertical axis to the mobile device's housing. In this embodiment of the device, the thumbwheel is oriented on an incline from the vertical in order to maximize PCB real estate. Orienting the thumbwheel on an incline will optimise the amount of space on the PCB and the thickness of the device housing.

Further features of the invention will be described or will become apparent in the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more clearly understood, the one or more embodiments thereof will now be described in detail by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a top view of the device with a multiple input mode thumbwheel;

Fig. 2 is a cut-away view of the device showing the location of the thumbwheel;

Fig. 3 is a detailed diagram of the top of the thumbwheel assembly describing the modes of movement of the thumbwheel;

Fig. 4 is a side view of the thumbwheel assembly;

Fig. 5 shows the translation of the thumbwheel assembly from a first position to a second position;

Fig. 6 is an exploded view of the thumbwheel assembly detailing the components of the thumbwheel assembly;

Fig. 7 is a block drawing for the thumbwheel input for a handheld electronic device;

Fig. 8 is a typical example of a circuit for a thumbwheel input.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a top view of an embodiment of the device with a multiple input mode thumbwheel. In this embodiment, the thumbwheel **12** is displaced on an incline from the vertical of the face of the mobile device housing **10**. The wheel **14** protrudes through the device housing **10**.

Fig. 2 is a cut-away view of the device showing a preferred location of the thumbwheel **12**. The PCB and other associated components that cooperate with the thumbwheel **12** receive and react to input provided via the thumbwheel is not shown. This drawing shows the bottom **10A** of the device housing and the placement of the thumbwheel **12** assembly within the housing.

Fig. 3 is a detailed diagram of the top view of the thumbwheel assembly describing the modes of movement of the thumbwheel. In this embodiment, the wheel **14** sits in the holder **16**, which is oriented on an angle from the horizontal plane **19** of the device housing **10**. In a preferred embodiment, this angle may be within a range of 0 to 45 degrees from the horizontal plane **19** to provide optimum space for PCB and PCB components, to reduce overall thickness of the device housing **10,** and to be optimised for use with the user's thumbs.

The user may make inputs with the thumbwheel by rotating in clockwise or counter-clockwise the wheel **14** around the thumbwheel's axis of rotation **18,** as illustrated by the rotation **r,** or by pressing down on the wheel, as illustrated by force **F**. In traditionally oriented thumbwheel inputs, the thumbwheel is pressed down toward the back of the device. Because the thumbwheel assembly is tilted on an angle in this embodiment, a second axis of rotation **20** exists along the bottom of the thumbwheel assembly **12**. When the user presses the exposed part of the wheel **14** from a first position, down toward the back of the device onto, the thumbwheel **12** translates to a second position approximately 0.5 mm downward. This motion of pressing downward onto the thumbwheel causes the thumbwheel to rotate around the second axis of rotation **20** in a rocking or seesaw motion, as illustrated by the rotation **R.** The movement of the thumbwheel in this direction is limited by the thumbwheel holder **16** and the device housing **10.**

Fig. 4 is a side view of the thumbwheel assembly. This view shows the bottom of the thumbwheel holder **16**. An arm **16A,** comprising a base portion and an arm portion, extends around the bottom of the assembly towards the holder for the purpose of

engaging the bottom of the holder **16** and activating an input. Between the arm **16A** and the holder **16** is a tactile switch **30**. When the user presses down on the exposed part of the wheel, the wheel **14** is stopped by the arm **16A** of the holder **16** and the tactile switch **30**. The tactile switch **30** is thus activated, receiving an input and the arm **16A** acts as a stop. The tactile switch **30** may be either attached to the bottom of the holder to engage the arm, or it may be attached to the arm to engage the bottom of the holder.

A further embodiment of the invention would be to eliminate the arm on the holder. In this example, part of the device housing may be used to perform the stop function of the arm. The device housing may have a protrusion on which the assembly may sit so that the tactile switch may be attached to the protrusion or if the tactile switch is on the bottom of the assembly, it may engage the protrusion.

Fig. 5 shows the translation of the thumbwheel assembly from a first position to a second position. When the user presses down on the wheel **14** in the direction of **F**, the thumbwheel assembly **12** moves from a first position β_1 to a second position β_2 around the second axis of rotation **20**. When the user releases the wheel **14**, the thumbwheel assembly **12** returns to the first position β_1. The translation in the direction of the force **F** is such that the thumbwheel assembly **12** will engage the tactile switch **30** to detect or receive an input.

Fig. 6 is an exploded view of the thumbwheel assembly. The wheel **14** sits on a rotating encoder switch **34** such that the lower axle **14A** of the wheel **14** sits in an recess on the rotating encoder switch **34** allowing the wheel to rotate around its axis of rotation **18.** This switch detects inputs to the device whenever the wheel is rotated around

the wheel's axis of rotation **18**. This switch is attached to the thumbwheel assembly PCB **32**. The thumbwheel assembly PCB **32** attaches to the device PCB by a flex circuit (not shown in this view). These parts fit into the thumbwheel holder **16** such that the wheel **14** and the rotatable encoder switch **34** is supported by a U-shaped bracket **16B**. The upper axle **14A** of the wheel fits into the provided aperture **16C** in the upper bracket of the U-shaped bracket **16B** and the rotatable encoder **34** switch fits into the provided indentation **16D** in the lower bracket of the U-shaped bracket **16B**. The rotatable encoder switch **34** attaches to the thumbwheel assembly PCB **32,** which is placed on the under side of the lower bracket of the U-shaped bracket **16B**. The thumbwheel assembly PCB **32** is in contact with the tactile switch **30** on the opposite side of this PCB than the rotatable encoder switch **34**. The tactile switch engages the holder arm **16A** in order to limit the movement of the thumbwheel about the holder's axis of rotation **20**.

Fig. 7 is a general block diagram depicting the inputs of a typical handheld electronic device. A typical handheld electronic device would usually include a microprocessor **400** that controls the components of the device such as a display, FLASH memory **600**, RAM **700**, and inputs in the form of a keyboard **900**, and an auxiliary input such as a thumbwheel **1000** which would include thumbwheel control logic **1010.**

Fig. 8 is an example of typical logic circuitry **1010** associated with thumbwheel **1000**. This diagram is meant for example purposes only and as one skilled in the art would understand, logic circuitry for a thumbwheel is not limited to this example. Thumbwheel **1000** outputs quadrature signals phase A **1021** and phase B **1022**, which are processed by D flip-flops **1031** and **1032** to present signals **1041** W_UP and **1042** W_DN

to microprocessor **400**. Signals **1041** and **1042** represent, respectively, a user rolling the thumbwheel up and rolling the thumbwheel down. Preferably, another detectable input movement from the thumbwheel is desirable. One such input movement implementation would produce an additional input signal derived from pushing the thumbwheel toward the rear of the device. Hence, the thumbwheel of the present invention has preferably measurable rotatable and depressible input movements. Although the description that follows is specifically relating to a thumbwheel input device, it is to be understood that other suitable thumb-based auxiliary input devices having multiple input detectable movements are envisioned and well within the scope and spirit of the present invention.

Another embodiment of this circuitry may have the functionality of the D flip-flops **1031** and **1032** embedded within the processor.

It will be appreciated that the above description relates to the preferred embodiment by way of example only. Many variations on the invention will be obvious to those knowledgeable in the field, and such obvious variations are within the scope of the invention as described and claimed, whether or not expressly described.